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TEST 5 — 100% OUTDOOR AIR HANDLING UNIT BUILDING AUTOMATION — DESIGN

Choose the correct answer (from the choices in bold) for each of the following hvac situations. See the schematic on the next page.

1 **Occupied-unoccupied control, in the “unoccupied” position:**
Time-of-day clock (TC-1) shall shut down air-handling unit during unoccupied cycle. Outdoor damper D-1 is closed, face and bypass damper D-2 is in the **(full face, modulating, full bypass)** position, heating hot water-steam valve is open but under the control of temperature transmitter TT-3 set at 50 F, chilled-water or direct-expansion cooling valve is closed, and fan motor is off.

2 **Occupied-unoccupied control, in the “occupied” position:**
Time-of-day programmed clock (TC-1) shall signal unit to start. Outdoor damper D-1 is open, with end switch ES-1 confirming contact to allow fan motor is start at minimum speed via variable-speed drive vsd.

3 **Maximum cooling:**
Bypass damper D-2 is in the “full face” position, heating valve is closed, cooling valve is open 100%, based on room thermostat TT-4 set at 76 F, resetting discharge air temperature transmitter TT-1 signal to **(minimum, maximum)** cooling setpoint of 55 F.

4 **Minimum cooling:**
Bypass damper D-2 is in the “full face” position, heating valve is closed, cooling valve modulates towards closing based on room thermostat TT-4 set at 76 F, resetting discharge air temperature transmitter TT-1 discharge air temperature transmitter TT-1 signal to minimum cooling setpoint of 60 F.

5 **Free cooling:**
Bypass damper D-2 is in the “full face” position, heating valve is closed, cooling valve is closed, and room thermostat **(TT-4, TT-3, TT-2)** set at 76 F is satisfied with discharge air.

6 **Minimum heating:**
Bypass damper D-2 is in the “full face” position, heating valve modulates open, based on room thermostat TT-4 set at 76 F, resetting discharge air temperature transmitter TT-1 signal to minimum heating to maintain setpoint of 60 F, and **(heating, cooling)** valve is closed.

7 **Maximum heating:**
When outdoor air temperature drops below 38 F based on temperature transmitter TT-2, heating valve shall open 100% and bypass damper D-2 shall modulate to “bypass,” based on room thermostat TT-4 set at 76 F, resetting discharge air temperature transmitter TT-1 signal to maximum heating to maintain setpoint of 60 F and cooling valve is closed.

8 **Variable-speed drive control:**
Space “positive pressure” shall be maintained at 0.05 in. wg. Differential pressure transmitter with P-1 space high-side setpoint and P-2 outdoor air low-side setpoint shall vary the speed of the fan motor vsd from slow speed at start-up to **(minimum, nominal,**

maximum) supply air to maintain room pressure. When space pressure is satisfied, vsd shall slow the fan speed toward low flow.

9 **Alarms controls:**
Freeze stat F-1 set at 38 F shall shut down fan motor and system components will go to their “fail safe” positions — outdoor damper **(D-1, D-2, V-1)** is closed, face and bypass damper D-2 is in the “full face” position, heating valve is open, cooling valve is closed, and fan motor is off. Manual reset of system will be required to restart the system.

Duct smoke detector shall shut down fan motor, signal an alarm condition to the fire alarm system, and system components will go to their “fail safe” positions — outdoor damper D-1 is closed, face and bypass damper D-2 is in the “full face” position, heating valve is open, cooling valve is closed, and fan motor is off. Manual reset of system will be required to restart the system.

10 **Building automation:**
Dirty filter — DP-1 differential pressure transmitter shall continuously measure the air **(dust, pressure, cfm)** drop across the air handling unit filter through the building automation computer. When the pressure resistance reaches its recommended “hi-limit,” DP-1 shall signal the building automation computer to issue a filter replacement work order.

Btuh meters — Heating energy meter M-1 and cooling energy meter M-2 shall continuously measure hvac energy through the building automation computer to record actual **(heat, cooling, energy)** versus budgeted profile energy in Btuh/sq ft/year. Outdoor air temperature transmitter TT-2 shall provide degree day totals to the energy calculations.

Run time — Electrical energy via the vsd unit shall continuously record fan motor run-hours through the building automation **(system, computer, controls)**. At the air handling unit manufacturer’s recommendation, “maximum hours of operation” will signal the building automation computer to issue a planned maintenance workorder.

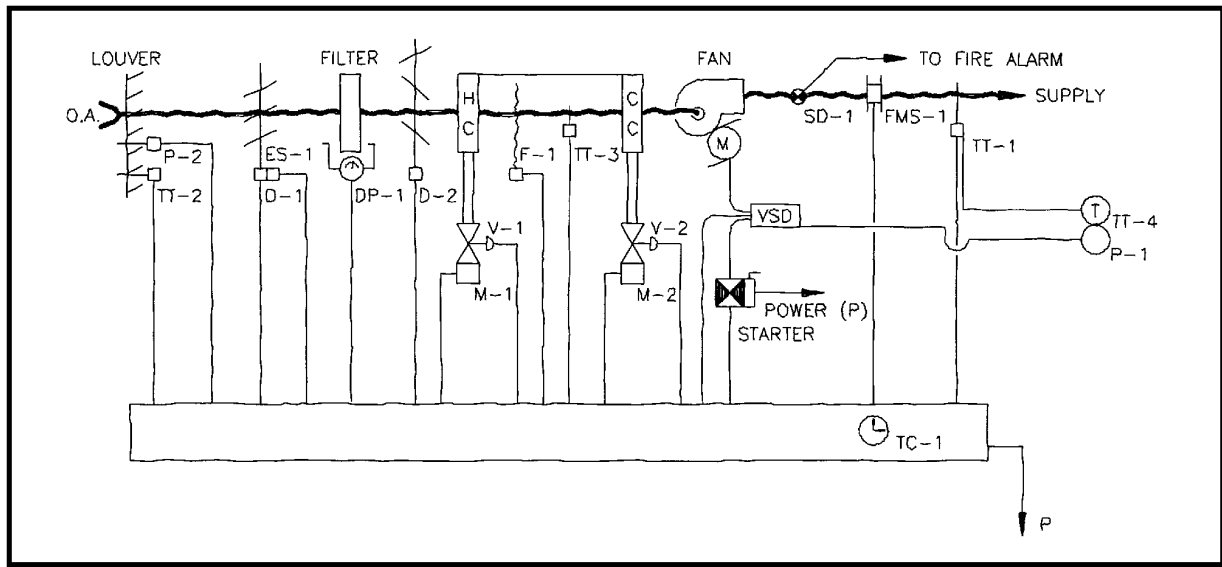
Flow-measuring station — FMS-1 transmitter shall continuously record **(outdoor, return, exhaust)** air ventilation in cfm.

Direct digital control devices — Ddc devices shall be programmed to routinely self-trend the entire sequence of operation for sequential accuracy.

If you have any questions regarding the Building Automation — Commissioning test, fax your concerns, questions, and/or comments to: Rebecca Ellis, P.E., 612-546-0494.

ANSWERS FOR BUILDING AUTOMATION — COMMISSIONING: 1. a) pressure; b) does; 2. a) increases; 3. a) increases; 4. a) stays the same; b) 0 cfm; 5. a) increases; b) greater than; 6. a) increases; 7. a) normal.

TEST 6 — 100% OUTSIDE AIR HANDLING UNIT BUILDING AUTOMATION - COMMISSIONING



Choose the correct answer (from the choices in **bold**) for each of the following hvac situations, referring to the schematic diagram on this page.

- 1 Set filter differential pressure transmitter (DP-1) high limit setpoint to a value lower than the current DP-1 reading and verify that:
 - a) The building automation computer (issues, does not issue) a filter-replacement workorder.
 - b) The fan (does, does not) continue running.
- 2 Reset DP-1 high limit setpoint back to original value. Manually override heating valve V-1 to its full-open position and verify that:
 - a) Heating energy meter M-1 reading (increases, decreases, stays the same).
- 3 Release the heating valve V-1 override and manually override cooling valve V-2 to full open. Verify that:
 - a) Cooling energy meter M-2 reading (increases, decreases, stays the same).
- 4 Release the cooling valve V-2 override. Put the system into unoccupied-mode operation via time clock TC-1. Verify that:
 - a) The building automation system runtime hours reading (increases, decreases, stays the same).
 - b) Airflow measuring station FMS-1 reading is (0 cfm, minimum cfm, maximum cfm).
- 5 Return system to occupied mode operation via time clock TC-1 and verify that:
 - a) The building automation system runtime hours reading (increases, decreases, stays the same).
 - b) Airflow-measuring station FMS-1 reading is (greater than, less than, equal to) 0 cfm.
- 6 Manually override vsd signal to 20% greater than current speed and verify that:
 - a) Airflow-measuring station FMS-1 reading (increases, decreases, stays the same).
- 7 Release the vsd signal override and verify that:
 - a) System resumes (normal, alarm condition) operation.

If you have any questions regarding the Building Automation — Design test, fax your concerns, questions, and/or comments to: Howard McKew, P.E., 978-887-1116 (fax); or via e-mail to hmckew@sebesta.com.